REMARKS

Status of the Claims

Claims 1-37 are pending. Claims 1, 3-8, 12, 13, 18, 20-22, and 25-28 stand rejected, and claims 2, 9-11, 14-17, 19, 23, 24, and 29-37 have been allowed. The Applicants sincerely thank the Examiner for allowing these claims. Claims 1, 6, 12, and 18 are amended.

Claim 1 has been amended to address its rejection under 35 U.S.C. §112¶2 and to more particularly point out the invention. Claims 6 and 18 have been amended to conform to the claim language of amended claim 1, and claim 12 has been amended to conform to the amended antecedent basis of claim 6. The undersigned believes these amendments do not add new matter.

The specification has been amended to correct obvious typographical errors. The undersigned believes these amendments do not add new matter.

Rejections under 35 U.S.C. §112

Claims 1 and 3-5 stand rejected as being indefinite because the phrase "a mirror movably attached" is unclear. The Examiner assumed the phrase to be "a mirror rotatably attached" for purposes of examination. Claim 1 has been amended to recite that the mirror is rotatably attached. The Applicants believe this amendment overcomes these rejections, and respectfully request reconsideration of the claims and removal of these rejections.

Rejections under 35 U.S.C. §102

Claims 1, 3-8, 12, 13, 18, 20, 21, 25, 26 and 28 stand rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,449,406 by Fan et al. (hereinafter "Fan"). The Examiner cites Fan for disclosing an optical switch comprising a mounting substrate **(1738)**, a micro-electro-mechanical system ("MEMs") die **(1710)** mounted on an edge to the mounting substrate, the MEMs die including a mirror **(1720)** rotatably attached to a base portion of the MEMs die with a flexure hinge, the mirror rotating from a first position to a second position in a plane essentially normal to a major surface of the mounting

substrate. The Applicants respectfully traverse the Examiner's position.

Claim 1 recites, among other elements, a MEMs die mounted on an edge to the mounting substrate. As explained on page 7, lines 1-12, the term "die" refers to an individual MEMs cell that includes a base portion **12** and a pivoting member **14**. The base portion **12** is mounted to the mounting substrate at an edge **21** of the die. A single die can be arranged on a substrate, as shown in Fig. 5D, or several dice can be arranged on a substrate, as shown in Figs. 5A-5C. Mounting a die on its edge enables several advantages, such as fabricating a high-quality mirror on a major surface of the die (Page 11, lines 7-8), electrically coupling edge-mounded dice to a printed wiring substrate (Page 8, lines 4-7), individually testing a die prior to assembly (Page 22, lines 7-9), individually selecting dice according to their position in a switching array (Page 20, lines 25-34) and individually aligning the die to associated optical ports (Page 21, lines 1-28).

Fan does not mount a MEMs die on an edge, but rather uses wafer-scale bonding to fabricate a plurality of optomechanical switching cells that is attached to a substrate as a single matrix switch (Col. 6, line 45- Col. 7, line 3). Fan states that an advantage of this wafer-scale approach is that there is less variation in the angle of the micromirrors, whereas the present invention teaches that individual alignment allows optimizing switch characteristics, such as insertion and polarization-dependent losses (Page 21, lines 2-4). Referring to another embodiment utilizing self-assembled mirror blocks, Fan states that "[a] significant advantage of this self-assembly process is that no individual mirror placement or alignment is needed." Col. 8, lines 45-47. Thus Fan does not disclose the present invention, and does not suggest the invention because it teaches away from aligning individual MEMs cells.

Claim 1 is amended to more particularly point out the invention. As discussed in association with Figs. 1A-1C, the mirror **15** lies in the plane of a major surface **57** of the MEMs die **10**. The mirror **15** moves in the plane of the major surface of the die (*compare* Fig. 1A to Fig. 1B). Thus, claim 1 has been amended to recite the motion of the mirror relative to the major surface of the die, rather than relative to the major surface of the substrate, further highlighting the difference between the edge **21** of the die **10** and the major surface **57** of the die. The Applicants believe claim 1 and all claims that depend from claim 1 are allowable, and respectfully request reconsideration of these rejections.

Claim 5, which depends from claim 1, recites that the mirror has a first mirrored

surface and a second mirrored surface opposite the first mirrored surface, in other words, a two-sided mirror. An application for such an optical switch is discussed in relation to Fig. 5D. For example, if the two-sided mirror **301** is extended, a light beam from input port **293** will be reflected to output port **299** off a first surface of the mirror, and a light beam from input port **295** will be reflected to output port **297** off a second surface of the mirror. This configuration is merely exemplary for purposes of convenient discussion. For example, the recited second position is the extended position, but an example where the second position is the retracted position could also be used.

In order to anticipate claim 5, Fan must disclose a two-sided mirror, and an optical switch with two input ports and two output ports, *i.e.* four optical ports, that couple in the recited fashion from the operation of the two-sided mirror. The Examiner cites Col. 12, lines 19-43 and Fig. 13 of Fan for disclosing mirrors **(1330)** and **(1340)** that have reflective surfaces on both sides, the second mirrored surface being opposite the first mirrored surface. However, claim 5 recites that the mirror of claim 1 has a first mirrored surface and second mirrored surface. Neither the first mirror **(1330)** or the second mirror **(1334)** of Fig. 13 appears to be a two-sided mirror.

Furthermore, Fig. 13 shows one set of input fibers, and two sets of output fibers. Taking the first mirror **(1330)** as an example, it couples the optical signal from the input fiber to the opposite ("upper") output fiber when the mirror **(1330)** is out of the beam path, and along beam path **(21)** to the associated side output fiber. Even if the mirror **(1330)** were a two-sided mirror, which it is not, and a second input signal was received from the upper (output) fiber, for example, the second input signal would not be coupled to any optical port, but merely be reflected away, *i.e.* there are only three optical ports, not four, associated with the mirror **(1330)**. Therefore, it is the Applicants' position that Fan does not disclose or suggest the recited second input fiber, does not disclose or suggest the recited mirror with first and second mirrored surfaces, and that claim 5 is further patentable.

Claim 6, as amended, recites, among other elements a first MEMs optical switch die affixed to a mounting surface on its edge. Claim 6 further recites that a first optical switching element is rotated in a plane essentially parallel to a major surface of the first MEMS optical switch die. As discussed above in support of claim 1, Fan discloses integrated arrays of MEMs cells, and does not mount a first MEMs optical switch die to a

mounting surface on its edge. Separately mounting the first and second MEMs optical switch dice to the mounting surface allows individual alignment of their respective optical switching elements, which Fan teaches away from. Therefore, the Applicants believe that claim 6 and all claims that depend from claim 6 are allowable.

Claim 13, which depends from claim 6, recites that the first optical switching element is a two-sided mirror and is therefore further allowable for substantially the same reasons provided above in support of claim 5. In particular, when the two-sided mirror is in the beam path, the first optical input is reflected to the first optical output and the second optical input is concurrently reflected to the third optical output. Referring to the 4 x 4 ADD/DROP cross connect illustrated in Fig. 5C of the present invention, the optical signal from a first input fiber **241** is reflected off the first mirrored surface of two-sided mirror **263** to a first output fiber **267** when the two-sided mirror **263** is in the beam path, and the optical signal from a second input fiber **269** is reflected off the second mirrored surface of two-sided mirror **263** to a third output fiber **271**. When the two-sided mirror **263** of the first MEMs die **265** is retracted out of the beam path from the first input fiber **241** and the second optical switching element (between the first MEMs die **265** and the third output fiber **271**) is in the beam path, the optical beam is directed to the second optical output, which is an output fiber to the right of the first output fiber **267**. The Applicants respectfully request reconsideration of claim 13 and the removal of this rejection.

Claim 18, as amended, recites, among other elements, a first mirror that is rotated in a plane essentially parallel to a major surface of the first die. Fan does not disclose or suggest this element; therefore, the Applicants believe claim 18 is allowable.

Claim 20 recites, among other elements, an optical cross connect with NxM MEMs optical switch dice, each of the dice having a drive capable of switching a mirror from a first position to a second position. The present invention teaches that a die may be selected for a particular characteristic, such as reflectivity, and may be aligned to optimize an optical characteristic, such as polarization-dependent loss or insertion loss. Fan states that "an entire NxM switching matrix can be monolithically integrated on a single substrate, (*e.g.*, a single silicon integrated circuit chip)." (Col. 14, lines 40-42). Fan further states that aligning the monolithic switching arrays reduces the variation in mirror tilt; however, the relationship between mirrors is fixed. Therefore, Fan teaches away from claim 20 by using a single die (silicon integrated circuit chip) with an array of NxM optical switching

cells. The Applicants respectfully traverse the Examiner's characterization of the optical switching cells of Fan as "dice," and believe that one of ordinary skill in the art would distinguish between dice, as used in the present application, and a monolithically integrated switching matrix on a single circuit chip having several optical switching cells. Accordingly, the Applicants believe claim 20 and all clams that depend from claim 20 are allowable.

Claim 25 recites, among other elements, optically aligning a first MEMs die to direct a first optical beam from the first optical input to a first optical output, affixing the first MEMs die to a mounting substrate, and optically aligning a second MEMs die to direct a second optical input to a second optical output. As discussed above in support of claims 1 and 20, Fan does not disclose individually aligning and affixing MEMs dice to a mounting substrate, but rather aligning an array of optical switching cells to banks of optical fibers. As taught in the present application, a MEMs die can be optically aligned to associated ports to optimize an optical characteristic before being affixed to the mounting substrate. The second MEMs die can be independently aligned to its associated ports. For example, the dice may be aligned to minimize the insertion loss through each path, or be aligned to provide the same insertion loss through each path, or one path may be aligned to minimize insertion loss, and another to minimize polarization-dependent loss.

Fan does not disclose or suggest the method recited in claim 25. The Applicant's respectfully traverse the Examiner's characterization of the WDM micromirrors (**1330, 1340**) as "dice." The Applicants believe the WDM micromirrors (**1330, 1340**) are mirrors in a monolithic (*i.e.* single-chip) switch array. Fan asserts advantages for monolithic switch arrays (Col. 14, lines 34-47), and thus teaches away from the present invention. The Applicants believe claim 25 and all claims that depend from claim 25 are allowable.

Claim 28, which depends from claim 25, recites selection the first MEMs die according to a first mirror criterium and selecting the second MEMs die according to a second mirror criterium. Fan discloses wafer-scale mirror attachment (Col. 6, line 44 – col. 7, line 23) and disparages handing mirrors individually. Fan does not recognize the advantages of individually selecting MEMs die for mirror criteria, and the Applicants believe claim 28 is further patentable.

Rejections under 35 U.S.C. §103

Claims 22 and 27 are rejected as being unpatentable over Fan. The Applicants claim 22 depends from claim 20 and is allowable for at least the reasons provided above in support of claim 20. Furthermore, as taught in the present application on page 8, lines 13-23, a magnetic drive is particularly desirable because it allows operation at lower voltages, compared to a conventional electrostatic drive, provides sufficient force to efficiently switch a relatively large (heavy) optical element (page 12, lines 24-28; page 24, lines 15-16), and teaches how to sense the switch state of a magnetic drive (page 27, lines 1-32). Example 5 of Fan discloses a vertical mirror on a torsion plate configured to move with a push-pull electrostatic force, and it is unclear, from the disclosure of Fan, why one would be motivated to replace the push-pull electrostatic operation with the Permalloy-based torsion plate disclosed in Example 4.

Claim 27, which depends from claim 25 through claim 26, discloses applying a mechanical force to latch the first optical switching element in a retracted position. As taught in the written description on page 26, lines 20-30, the first optical element is aligned and then pushed to latch in the retracted position, which allows alignment of a second optical element along the same optical path. This enables subsequent dice to be aligned without having to provide electronic control signals to assembled dice. For example, a micromanipulator used to place and align a die could be used to push an optical element into a retracted position, facilitating alignment of subsequent dice. Fan does not disclose or suggest applying a mechanical force to latch the first optical switching element in a retracted position, and therefore claim 27 is further allowable.

CONCLUSION

In view of the foregoing, the Applicants believe that upon entry of this amendment all claims pending in this Application will be in condition for allowance. The Applicants respectfully request entry of this Amendment, reconsideration of the amended claims, withdrawal of the rejections, and the issuance of a formal Notice of Allowance at an early date.

If the Examiner believes this amendment does not put all pending claims in condition for allowance, the undersigned respectfully requests a telephone interview to expedite prosecution of this application, and invites the Examiner to telephone the undersigned at (707) 591-0789.

Respectfully submitted,

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